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(71) Applicant(s)
Baker Hughes Incorporated

(Incorporated in USA - Delaware)

3900 Essex Lane, Suite 1200, P.O.Box 4740 Houston, Texas 77210-4740, United States of America

(72) Inventor(s)
David K Green
Bruce Weightman

(74) Agent and/or Address for Service
Boult Wade Tennant
27 Furnival Street, LONDON, EC4A 1PQ, United Kingdom

(54) **Valve actuator**

(57) A valve actuator (A) can be selectively driven by fluid or electrical power, or both, in the alternative. A driving motor (18) engages a drive which, through a clutching mechanism ultimately engages the actuator shaft (44). The actuator shaft (44) has a spiral groove (46) which is ultimately engaged by cammed spheres moved into the groove (46), thus making the drive system which is retained longitudinally, drive the shaft upon rotation of the drive system. Upon release of energy to the driver, be it electrical, hydraulic, or pneumatic, the clutching system disengages so that the balls come out of contact from the spiral groove (44) allowing a return spring (80) to snap the valve (V) shut by longitudinal movement of the actuator shaft (46).

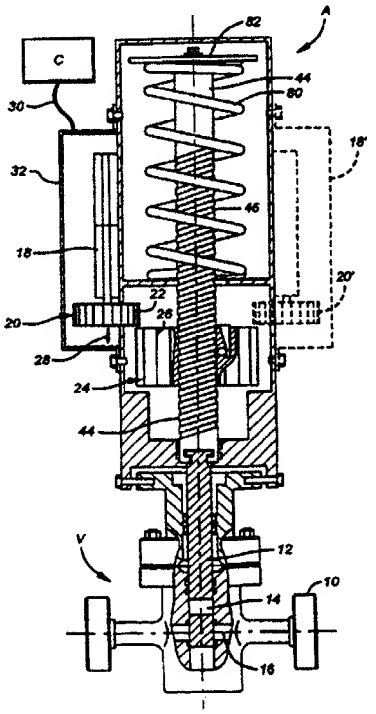

FIG. 1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

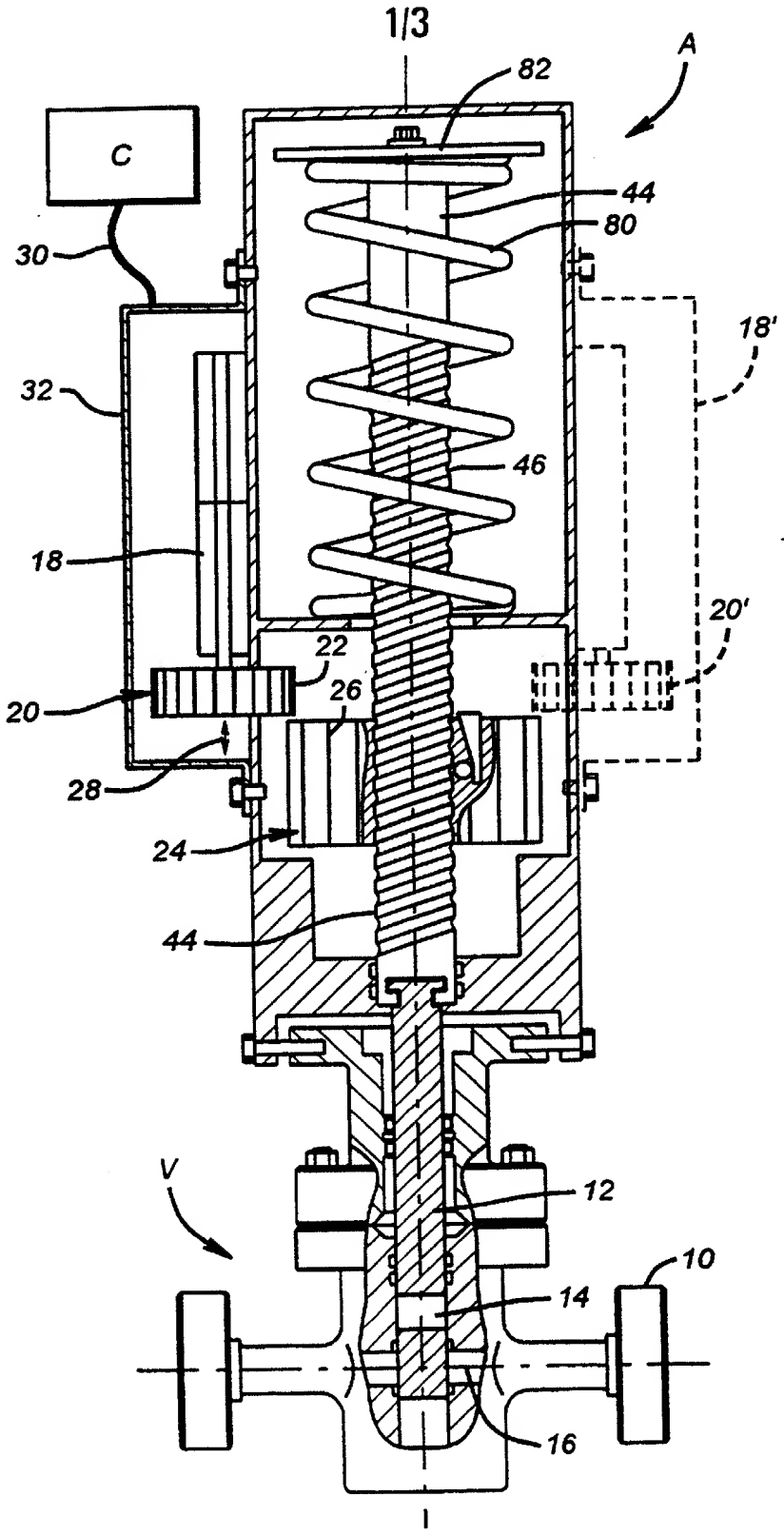

FIG. 1

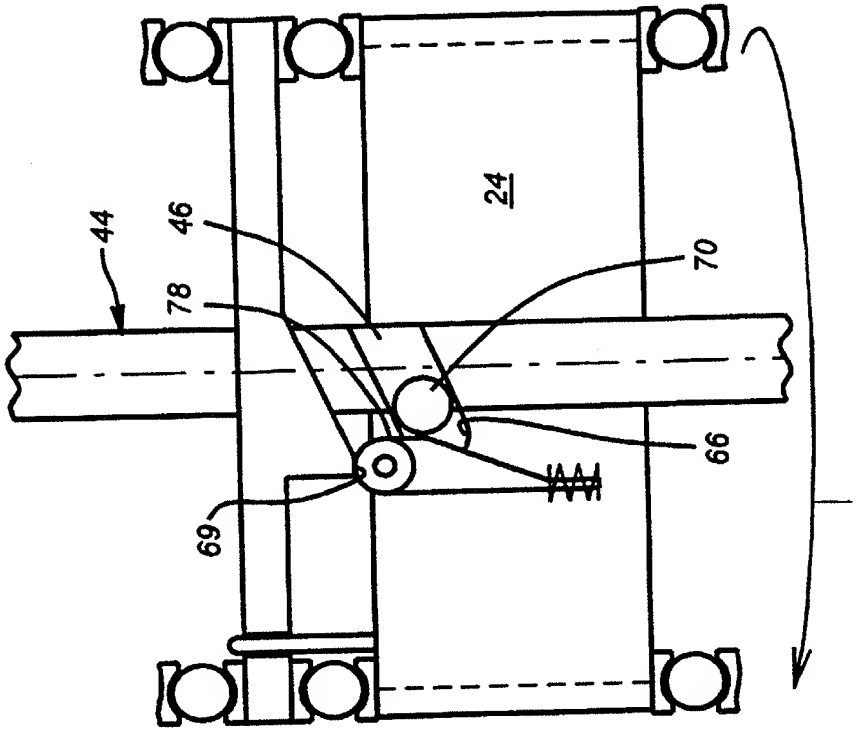

FIG. 3

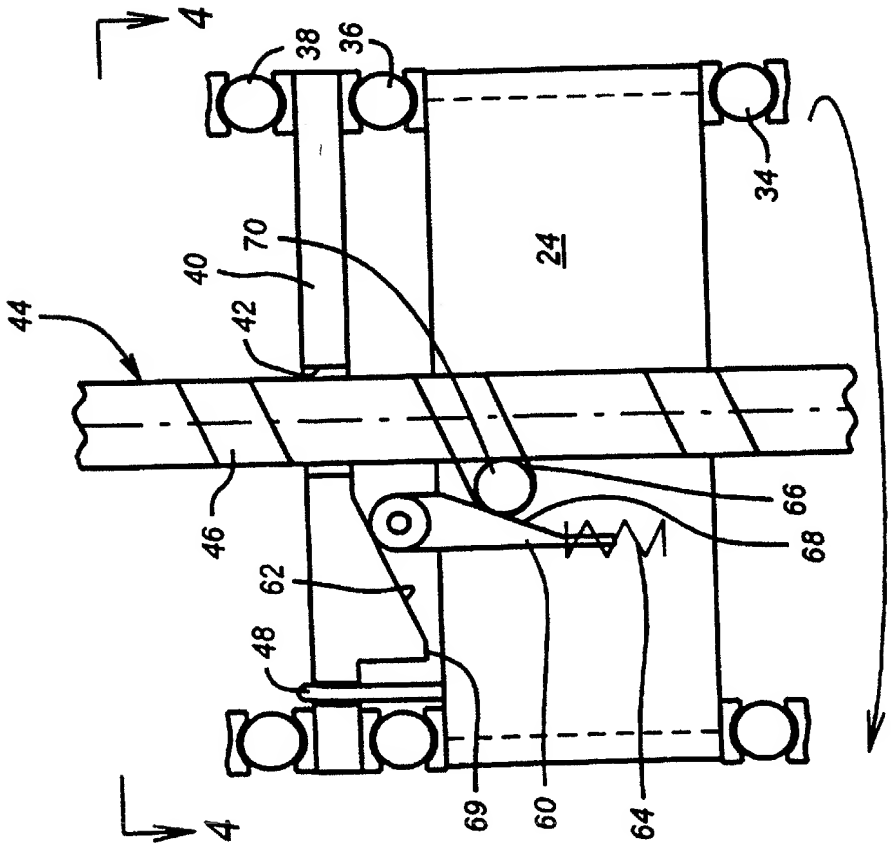

FIG. 2

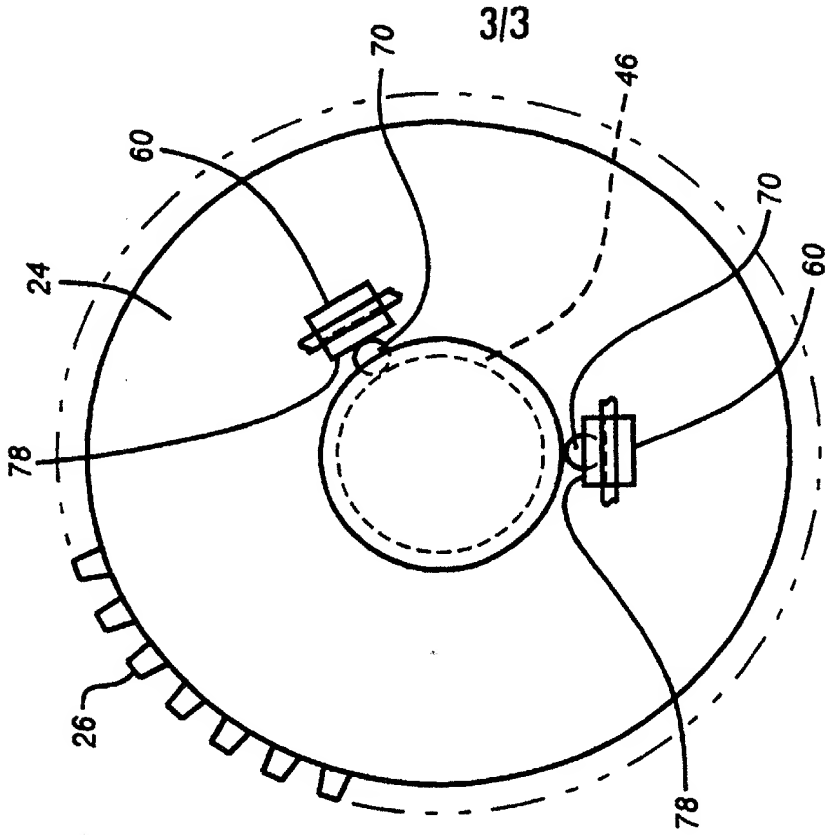

FIG. 5

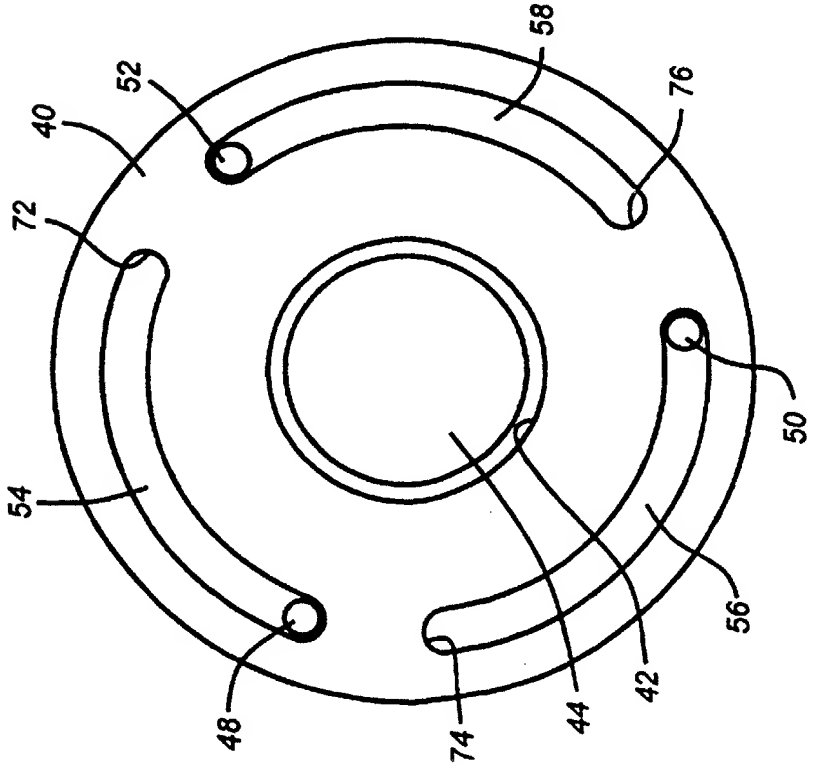

FIG. 4

VALVE ACTUATOR

FIELD OF THE INVENTION

The field of this invention relates to valve actuators for surface and subsea applications.

BACKGROUND OF THE INVENTION

Valve actuators are commonly used to operate valves on the surface or in subsea applications. Typically, there is an arrangement of valves at the wellhead known as a "Christmas tree," and a control system for normal and emergency operation of such valves. This same assembly can also be used subsea. In the past, valve actuators have typically involved the use of hydraulic fluid pressure to actuate a piston against a return spring. The valve is typically held open by maintenance of hydraulic pressure keeping a return spring in the extended position. Should there occur a need for an emergency shutdown of a particular valve, the hydraulic pressure is removed, allowing the spring to return the stem of the valve in question to the closed position, so that the valve may close. Typically, actuators are specifically designed to operate one or a series of related valves. However, there could occur situations where the operator, after initial installation of a system, wishes to convert a control system from hydraulic operation to electrical operation or vice versa. Generally speaking, if a system is outfitted with known designs that require, for example, hydraulic actuation, a conversion of the control system to electric operation will generally require significant costs in replacement of most likely entire actuator assemblies to accommodate the new source of power for the control system.

The apparatus of the present invention is configured with an objective to allow flexible operation by prime movers which are either hydraulically driven or electrically driven. To accomplish this objective, a driving system is employed for selective engagement of the actuator shaft on an as–needed basis. The drive system may run on electrical or hydraulic power, or both, if desired. The drive system ensures positive movement of the actuator shaft and accommodates a snap closure for fail–safe operations. In the past, valve actuators have come equipped with manual overrides which generally involve a handwheel operation. One such valve is the SRM Safety Release sold by Guiberson·AVA, now a subsidiary of Dresser Corporation. This type of a safety valve operates primarily by actuation of a hydraulic piston which compresses a return spring. However, a manual override is provided where the shaft turned by a handwheel involves engagement of a recessed spiral by a ball which, upon turning of the handwheel, results in sufficient movement of the shaft with the handwheel to operate the valve manually. While the ball in combination with a spiral groove on a shaft has been used for such manual operations, the object of the present invention is to employ such a technique as the main mode of automatic stem actuation and still incorporate an emergency shutdown feature while also accommodating drivers which are either hydraulic or electric and/or both. The manner in which such objectives are met will be more clearly understood by reviewing the detailed description of the pre–ferred embodiment below.

SUMMARY OF THE INVENTION

A valve actuator is disclosed that can be selectively driven by hydraulic or electrical power, or both, in the alternative. A driving motor engages a drive which, through a clutching mechanism ultimately engages the actuator shaft. The

actuator shaft has a spiral groove which is ultimately engaged by cammed spheres moved into the groove, thus making the drive system which is retained longitudinally, drive the shaft upon rotation of the drive system. Upon release of energy to the driver, be it electrical, hydraulic, or pneumatic, the clutching system disengages so that the balls come out of contact from the spiral groove allowing a return spring to snap the valve shut by longitudinal movement of the actuator shaft.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a sectional elevational view showing the actuator of the present invention with the underlying valve in the closed position.

Figure 2 illustrates the movements that occur to open the valve depicted in Figure 1.

Figure 3 illustrates the continuing movements illustrated in Figure 2, which cams the balls into the spiral track for driving the actuator shaft to open the valve depicted in Figure 1.

Figure 4 is a top view taken along lines 4–4 of Figure 2.

Figure 5 is a schematic illustration in a single drawing of two positions showing the balls out of engagement with the spiral track, as well as in engagement, and the interaction between the balls and the wedge device which drives them.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Figure 1, the valve body **10** is shown with the slide **12** having its opening **14** misaligned with the main bore **16** of the valve **V**. This is the position before the drive motor **18** forces driving pinion **20**, which has teeth **22**, into engagement with gear **24** via its teeth **26**. Arrow **28** represents schematically

that the pinion 20 can move longitudinally in the direction of the arrowheads of arrow 28 for a selective engagement or disengagement between teeth 22 and 26. While square cut gears are schematically illustrated, those skilled in the art will appreciate that other types of drives can be used without departing from the spirit of the invention.

A control system illustrated schematically as C is connected through a conduit 30 to the housing 32. The actuator A of the present invention can have one or more such housings 32 disposed at its periphery which can hold one or more drive motors 18. This multidrive or alternative drive arrangement is shown schematically using a dashed housing and drive motor 18'. Accordingly, some of the combinations that can be used are a single driver 18 which is either hydraulically or electrically driven. A redundant spare driver 18' can be used, which is driven in the same manner as the driver 18 that it is intended to replace. Or, alternatively, drivers 18 can be used with the capability of operating them through a control system C operated either through fluid drive or electrically. Those skilled in the art will appreciate that the design of the drive motor 18 is akin to the operation of a starting motor on a motor vehicle where rotation of the starting motor throws a driving pinion along a shaft into engagement with another gear to turn the engine to start up. The same concept can be employed with the driver 18 or 18', illustrated in Figure 1. Arrow 28 illustrates the concept of longitudinal movement of pinion 20. Accordingly, if the driver 18 is energized, it begins to rotate turning pinion 20 while driving it longitudinally in the direction of gear 24 until teeth 22 engage teeth 26 which, in turn, starts gear 24 rotating.

Referring now to Figure 2, it can be seen that gear 24 is longitudinally restrained by thrust bearings 34 and 36. Similarly, thrust bearings 36 and 38 longitudinally restrain plate 40. Plate 40 has a central opening 42. Actuator shaft

44 extends through opening 42, as shown in Figure 2. Shaft 44 has a spiral groove 46 which, as shown in Figure 1, extends through a significant portion of its length. Gear 24 has a series of pins 48, 50, and 52. Each of the pins 48, 50, and 52 extend through a corresponding slot 54, 56, and 58, respectively. Housed within gear 24 is a plurality of wedges 60. In the preferred embodiment, three wedges are disposed circumferentially within gear 24 about shaft 44. The plate 40 has a series of ramps 62. In the preferred embodiment, there are three such ramps 62, each to contact a respective wedge 60 upon relative rotation between the gear 24 and the plate 40. Each of the wedges 60 is biased upwardly by a spring 64. Accordingly, the "up" position illustrated in Figure 2 is the normal position with pinion 20 disengaged from gear 24. Within gear 24 and adjacent to each wedge 60 is a ball receptacle 66. When the taper 68 drives the balls 70 as a result of being cammed by ramp 62 against spring 64, balls 70 are respectively pushed out of ball receptacle 66 until such time as sufficient rotation of gear 24 occurs to bring the balls 70 in alignment with the spiral groove 46. At this time, wedge or cam 60 moves onto flat spot 69 adjacent taper 68 with the wedge or cam 60 resting on flat spot 69. Spring 64 will not cause plate 40 to turn which, if it occurred, could allow wedge 60 to move up ramp 68 to undesirably release balls 70 from spiral groove 46. Without flat spot 69, spring 64 would push cam 60 along sloping surface 68 which would turn plate 40 to release balls 70 from groove 46. Further rotation of the gear 24 with the balls 70 engaged in spiral groove 46 drives the shaft 44 downwardly which ultimately pushes down slide 12 until opening 14 is aligned with main bore 16 putting the valve V in the open position.

In order to cam the balls 70 out of receptacle 66, the control system C through conduit 30 which can be a pneumatic conduit or a electrical conduit, depending on the nature of the final driver 18, is used to engage the driver 18 so

as to move the pinion 20 in the direction of arrow 28 downwardly toward gear 24. When teeth 22 mesh with teeth 26, continuing rotation of driver 18 turns gear 24. Bearings 34 and 36 keep gear 24 from moving longitudinally. Sufficient resistance to rotation of plate 40 exists from bearings 36 and 38 so that initial rotation of gear 24 moves the pins 48, 50, and 52 to slot ends 72, 74, and 76, respectively. As this is occurring, the gear 24 is rotating with respect to the plate 40 which remains stationary. As rotation of gear 24 occurs, the wedges 60 come in contact with an ride-down ramp 62. As a result, all of the wedges 60 are forced down against the respective spring 64 which in turn cams each of the balls 70 radially inwardly toward shaft 44. By the time the pins 48, 50, and 52 reach the opposite slot ends 72, 74, and 76, respectively, the balls 70 have already entered into groove 46 and have been locked in as surface 78 moves into contact with the balls 70 in effect locking gear 24 to shaft 44. This position is illustrated in Figure 3.

Figure 4 illustrates the position prior to rotation of gear 24 illustrating how the gear 24 with its pins 48, 50, and 52 has approximately 90° of rotational movement before encountering the opposite slot ends 72, 74, and 76, respectively. Recenter of the slots 54, 56, and 58 are approximately 120° apart. While an installation showing the use of three pins in matching slots has been used, other types of camming and/or clutching mechanisms can be employed without departing from the spirit of the invention. For example, one or a plurality of wedge and ball systems can be used or some other clutching technique can be used for engagement of the spiral path 46. What is important is that when the time comes, the clutching system provides flexibility for a complete disengagement of shaft 44 from gear 24 so that return spring 80 (see Figure 1) can pull or push the shaft 44 upwardly, thus retracting the slide 12 and moving opening 14 out of alignment with main bore 16 to close the valve V.

What has thus far been described is how the drive motor 18 puts pinion 20 in contact with gear 24 to initiate the camming action that gets the balls 70 into groove 46. With the longitudinal restraints, as previously described, from bearings 34, 36, and 38, relative rotation between gear 24 and plate 40 occurs until the pins 48, 50, and 52 meet slot ends 72, 74, and 76, respectively. By that time, balls 70 have been cammed by surfaces 68 and are now held out into spiral groove 46 by surface 78. Continuing rotation of gear 24 drives the shaft 44 down to open the valve V. Once the valve V has its slide 12 bottom in the body of the valve, the entire assembly, including pinion 20 and gear 24, stalls. At this time, the control system C maintains power, be it in hydraulic or electrical form, to driver 18 to have it hold its position with pinion 20 engaged to gear 24. Accordingly, reverse action or rotation of gear 24 is prevented which will close the valve V prematurely. While using the control system C is one means of maintaining the position of gear 24 against rotation induced by the effect of spring 80 acting on plate 82, those skilled in the art will appreciate that other techniques can be used to prevent unwarranted reverse rotation of gear 24 which will allow valve V to close at the wrong time. However, when it is desired that valve V should be closed, one technique to accomplish this involves using the control system C which communicates with the driver 18. If the hydraulic or electrical supply is interrupted, the pinion 20 is no longer capable of engaging gear 24. At this time, pinion 20 is retracted longitudinally to take teeth 22 out of engagement with teeth 26. The configuration of the teeth 22 and 26 can assist pinion 20 in moving away from gear 24. Other known retraction techniques can be used on pinion 20. Spring 80 then pushes plate 82 up which pulls up shaft 44. Reverse movement occurs so that the initial rotation of gear 24 allows the wedges 60 to come up as they ride up ramp 62 pushed on by spring 64. As soon as sufficient relative rotation between the

plate 40 and gear 24 has occurred, the balls 70 are, in effect, out of groove 46 and spring 80 can move shaft 44 straight up pulling with it slide 12, which then has its opening 14 taken out of alignment with main bore 16, and the valve V is closed. Those skilled in the art will appreciate that other techniques can be used to accomplish the release or valve closing procedure of valve V. For instance, the driver 18 can be of such a design that it can be driven in opposing directions and held in a stalled position with pinion 20 engaged to gear 24. For release, the driver 18 can be run backwards to accomplish the disengagement of balls 70 from spiral groove 46. As previously stated, other drive systems can be employed as long as a clutching mechanism is provided that selectively gets the balls 70 into the spiral groove 46 when needed for valve opening, and quickly, and as automatically as possible, gets the balls 70 out of groove 46 so that the return spring 80 can quickly translate the shaft 44 for closing of valve V.

Figure 5 schematically illustrates the balls 70 out of engagement with the spiral groove 46, as shown in the bottom of the figure, and for convenience the engaged position is also shown from the top with balls 70 held in spiral groove 46 by surface 78. Obviously, the engaged position is used for opening valve V while the release position at the bottom of Figure 5 is used for a quick emergency shutdown employing return spring 80.

Those skilled in the art will appreciate that what has been disclosed is a valve actuator that has the flexibility of being driven electrically, hydraulically, or with any fluid. One or more drivers 18 can be used so that different types of power can be used to operate a single actuator. Alternatively, the actuator A can have a housing that can accommodate, with quick change out, different drivers 18 while still using the same down-the-line mechanism to actuate the valve between open and closed. With that layout, the nature of the motive force for the driver 18

becomes immaterial to the operation of the actuator and, hence, the actuator can be retained despite a change out of power supply from electric to fluid or in reverse. The actuator A relies on a drive system with a clutching mechanism that employs the significant mechanical advantage available from engaging a ball, such as 70, in a spiral groove 46 for main actuation of the valve shaft 44 to open the valve. At the same time the clutching mechanism, composed principally of the plate 40 and its series of ramps 62, allows for a ready disengagement of the balls 70 from the spiral groove 46 so that the return spring 80 can quickly translate, rather than rotate, the shaft 44 to accomplish a quick closing of valve V. Various techniques have been described to initiate the opening movement of the balls 70 driving the spiral groove 46. While the preferred technique of the clutching mechanism has been disclosed, other clutching techniques used in combination with the ball/spiral groove method of actuation are within the purview of the invention, as long as the clutching systems allow for disengagement of the ball/spiral groove arrangement so that a closing spring, such as 80 or equivalent fail-safe closure assembly or mechanism can be used for quick translation of the actuator shaft for a rapid, emergency, or even a routine closing of the valve V.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made without departing from the spirit of the invention.

CLAIMS

1. A valve actuator comprising:

a housing;

a shaft movably mounted to said housing;

at least one driver mounted to said housing;

a drive operably connecting said shaft to said driver for selective movement of said shaft;

said drive interchangeably operable by said driver whether said driver is powered electrically or hydraulically.

2. The actuator of claim 1 wherein:

said drive further comprises:

a clutch assembly for selective engagement between said shaft and said drive.

3. The actuator of claim 2 wherein:

said shaft comprises a depression;

said drive comprises a projection, whereupon engagement of said projection into said depression allows said drive to translate said shaft.

4. The actuator of claim 3 wherein:

said projection comprises at least one ball;

said depression comprises at least one spiral groove;

said clutch assembly selectively brings said ball into said groove to drive said shaft by rotation of said drive which results in turning and advancing said shaft toward one of two end positions.

5. The actuator of claim 4 wherein:

said clutch assembly selectively releases said ball from said groove to allow said shaft to translate toward another of two end positions.

6. The actuator of claim 5 further comprising:

a return spring operably connected to said shaft and energized to store a force upon advancement of said shaft in a first direction with said ball in said groove;

said stored force acting on said shaft to translate it in an opposed second direction when said clutch assembly has allowed said ball to retract out of said groove.

7. The actuator of claim 6 wherein:

said clutch assembly further comprises:

a cam plate supported by said housing;

said drive comprises a pinion movably mounted to said driver for selective engagement with a longitudinally retained driven gear;

said driven gear further comprises at least one cam, said cam selectively engageable by said cam plate to engage said shaft to said driven gear.

8. The actuator of claim 2 wherein:

said clutch assembly further comprises:

a cam supported by said housing;

whereupon relative movement between said cam and said drive operably connects said shaft to said drive.

9. The actuator of claim 8 wherein:

said cam comprises a plate having a camming surface thereon;

said drive comprises a movably mounted camming member that is actuated by relative rotation between said plate and said drive.

10. The actuator of claim 9 wherein:

said camming member forces an object to project from said drive into a depression on said shaft.

11. The actuator of claim 10 wherein:

said drive is operably connected to said plate so that upon sufficient relative rotation to cam said camming member by said camming surface, said drive and said plate rotate in tandem to continue said camming.

12. The actuator of claim 11 wherein:

said camming member is biased with said camming surface overcoming said bias upon contact therewith;

movement of said camming member against said bias forces at least one ball into at least one mating spiral groove on said shaft;

said housing restraining said drive against longitudinal movement, whereupon rotation of said drive turns and advances said shaft.

13. The actuator of claim 12 wherein:

said drive comprises a driving member movably mounted to said driver and a driven member supported by said housing and surrounding said shaft;

said driven member comprises at least one pin and said plate comprises at least one slot;

whereupon initial rotation of said driven member does not turn said plate until said pin engages an end of said slot which only occurs after said camming surface has actuated said camming member.

14. The actuator of claim 13 wherein:

said camming surface comprises a flat segment which engages said camming member at a time near when said pin hits the end of said slot.

15. The actuator of claim 14 further comprising:

a return spring in said housing acting on said shaft;

said shaft retained against the bias force of said return spring by continuing engagement of said driving and driven member while said cam is on said flat segment;

whereon selective disengagement of said driving and driven members allows said return spring to initially turn said driven member with respect to said plate to release said ball from said groove to thereafter allow translation of said shaft by said return spring.

16. The actuator of claim 15 wherein:

said continuing engagement of said driving and driven members is accomplished by retention of power to said driver.

17. The actuator of claim 1 wherein:

said housing accommodates a plurality of drivers, each driven either electrically or hydraulically.

18. A valve actuator comprising:

a housing;

at least one motor driver mounted to said housing;

a drive connected to said driver;

a shaft operably connected to said drive by a clutch, said shaft biased toward a first direction;

said motor driver through said drive overcoming said bias on said shaft to move said shaft in a second direction;

said clutch selectively operable to disengage said drive from said shaft to allow said bias to translate said shaft in said first direction.

19. The valve actuator of claim 18 wherein:

said clutch further comprises at least one spiral groove on said shaft; and

at least one ball retained by said drive, said ball selectively cammed into said groove to facilitate driving said shaft with said drive by a combined translation and rotational movement.

20. The valve actuator of claim 19 wherein:

said clutch includes at least one camming surface selectively engageable with a cam on said drive, said cam selectively advancing said ball into said groove as a result of relative movement between said camming surface and said cam.

21. The valve actuator of claim 20 wherein:

said camming surface is formed on a plate that surrounds said shaft;

said drive comprises a driven member surrounding said shaft and retaining said ball therein until said ball is forced toward said groove by said cam;

said motor driver comprises a driving member selectively engageable with said driven member;

said driven member rotates with respect to said plate for a predetermined distance at which time said ball is cammed toward said groove and said driven member and said plate rotate in tandem to retain said ball to the groove.

22. The valve actuator of claim 21 wherein:

said camming surface has a flat spot on which said cam rides during said tandem movement.

23. The valve actuator of claim 22 wherein:

said motor driver selectively holds the position of said shaft by holding said driving and driven members in engagement without rotation with said ball still cammed into said groove.

24. The valve actuator of claim 23 wherein:

said motor driver selectively allows said driving and driven members to separate whereupon said bias on said shaft rotates said driven member to move said cam off of said flat spot and up said camming surface, and as a result said ball backs out of said groove and said bias on said shaft shifts it longitudinally.

25. The valve actuator of claim 24 wherein:

said housing accommodates at least one motor driver that is powered electrically or hydraulically.

26. The valve actuator of claim 25 wherein:

said housing accommodates a plurality of motor drivers, each powered either electrically or hydraulically.

27. The valve actuator of claim 18 wherein:

said housing accommodates at least one motor driver that is powered electrically or hydraulically.

28. The valve actuator of claim 27 wherein:

said housing accommodates a plurality of motor drivers, each powered either electrically or hydraulically.

29. The valve actuator substantially as hereinbefore described with reference to the accompanying drawings.

Amendments to the claims have been filed as follows

1. A valve actuator for moving a valve between an opened and a closed position comprising:

a housing;

an output shaft movably mounted to said housing and connectable to the valve;

at least one driver mounted to said housing;

a drive, said drive, when operably connecting said shaft to said driver allows said driver to move said shaft to place the valve in one of the opened or closed position;

said drive, when disengaged from said shaft, allows said shaft to translate to move the valve into the other of said open and closed positions; and said housing is configured to interchangeably accept electric and hydraulic drivers to engage said drive for movement of said shaft.

2. The actuator of claim 1 wherein:

said drive further comprises:

a clutch assembly for selective engagement between said shaft and said drive.

3. The actuator of claim 2 wherein:

said shaft comprises a depression;

said drive comprises a movably mounted projection, whereupon selective engagement of said projection within said drive and said depression resulting from initial rotation of said drive allows said drive to translate said shaft.

4. A valve actuator comprising:

a housing;

a shaft movable mounted to said housing;

at least one driver mounted to said housing;

a drive operably connecting said shaft to said driver for selective movement of said shaft;

said drive further comprises a clutch assembly for selective engagement between said shaft and said drive;

said shaft comprises a depression;

said drive comprises a projection, whereupon engagement of said projection into said depression allows said drive to translate said shaft;

said projection comprises at least one ball;

said depression comprises at least one spiral groove; and

said clutch assembly selectively moves said ball into said groove to drive said shaft by rotation of said drive which results in turning and advancing said shaft toward one of two end positions.

5. The actuator of claim 4 wherein:

said clutch assembly selectively releases said ball from said groove to allow said shaft to translate toward another of two end positions.

6. The actuator of claim 5 further comprising:

a return spring operably connected to said shaft and energised to store a force upon advancement of said shaft in a first direction with said ball in said groove;

said stored force acting on said shaft to translate it in an opposed second direction when said clutch assembly has allowed said ball to retract out of said groove.

7. The actuator of claim 6 wherein:

said clutch assembly further comprises:

a cam plate supported by said housing;

said drive comprises a pinion movably mounted to said driver for selective engagement with a longitudinally retained driven gear;

said driven gear further comprises at least one cam, said cam selectively engageable by said cam plate to engage said shaft by camming said ball into said spiral groove thereof to allow rotation of said driven gear to advance said shaft by a combined rotation and translation of said shaft.

8. A valve actuator comprising:

a housing;

a shaft movably mounted to said housing;

at least one driver mounted to said housing;

a drive operably connecting said shaft to said driver for selective movement of said shaft;

said drive further comprises a clutch assembly for selective engagement between said shaft and said drive;

said clutch assembly further comprises:

a cam supported by said housing; and

whereupon relative movement between said cam and said drive operably connects said shaft to said drive.

9. The actuator of claim 8 wherein:

said cam comprises a plate having a camming surface thereon;

said drive comprises a movably mounted camming member that is actuated by relative rotation between said plate and said drive.

10. The actuator of claim 9 wherein:

said camming member forces an object to project from said drive into a depression on said shaft.

11. The actuator of claim 10 wherein:

said drive is operably connected to said plate so that upon sufficient relative rotation to cam said camming member by said camming surface, said drive and said plate rotate in tandem to continue said camming.

12. The actuator of claim 11 wherein:

said camming member is biased with said camming surface overcoming said bias upon contact therewith;

movement of said camming member against said bias forces at least one ball into at least one mating spiral groove on said shaft;

said housing restraining said drive against longitudinal movement, whereupon rotation of said drive turns and advances said shaft.

13. The actuator of claim 12 wherein:

said drive comprises a driving member movably mounted to said driver and a driven member supported by said housing and surrounding said shaft;

said driven member comprises at least one pin and said plate comprises at least one slot;

whereupon initial rotation of said driven member does not turn said plate until said pin engages an end of said slot which only occurs after said camming surface has actuated said camming member.

14. The actuator of claim 13 wherein:

said camming surface comprises a flat segment which engages said camming member at a time near when said pin hits the end of said slot.

15. The actuator of claim 14 further comprising:

a return spring in said housing acting on said shaft;

said shaft retained against the bias force of said return spring by continuing engagement of said driving and driven member while said cam is on said flat segment;

whereon selective disengagement of said driving and driven members allows said return spring to initially turn said driven member with respect to said plate to release said ball from said groove to thereafter allow translation of said shaft by said return spring.

16. The actuator of claim 15 wherein:

said continuing engagement of said driving and driven members is accomplished by retention of power to said driver.

17. The actuator of claim 1 wherein:

said housing accommodates a plurality of drivers, at least one driven electrically and at least one driven hydraulically.

18. A valve actuator for a valve comprising:

a housing;

at least one motor driver mounted to said housing;

a drive connected to said driver;

a shaft operably connected to said drive by a clutch, said shaft biased toward a first direction and said shaft connectable to the valve;

said motor driver through said drive overcoming said bias on said shaft to move said shaft in a second direction;

said clutch selectively operable to disengage said drive from said shaft to allow said bias to translate said shaft in said first direction.

19. A valve actuator comprising:

a housing;

at least one motor driver mounted to said housing;

a drive connected to said driver;

a shaft operably connected to said drive by a clutch, said shaft biased toward a first direction;

said motor driver through said drive overcoming said bias on said shaft to move said shaft in a second direction;

said clutch selectively operably to disengage said drive from said shaft to allow said bias to translate said shaft in said first direction; and

said clutch further comprises at least one spiral groove on said shaft; and

at least one ball retained by said drive, said ball selectively cammed into said groove to facilitate driving said shaft with said drive by a combined translation and rotational movement.

20. The valve actuator of claim 19 wherein:

said clutch includes at least one camming surface selectively engageable with a cam on said drive, said cam selectively advancing said ball into said groove as a result of relative movement between said camming surface and said cam.

21. The valve actuator of claim 20 wherein:

said camming surface is formed on a plate that surrounds said shaft;

said drive comprises a driven member surrounding said shaft and retaining said ball therein until said ball is forced toward said groove by said cam;

said motor driver comprises a driving member selectively engageable with said driven member;

said driven member rotates with respect to said plate for a predetermined distance at which time said ball is cammed toward said groove and said driven member and said plate rotate in tandem to retain said ball to the groove.

22. The valve actuator of claim 21 wherein:
said camming surface has a flat spot on which said cam rides during said tandem movement.

23. The valve actuator of claim 22 wherein:
said motor driver selectively holds the position of said shaft by holding said driving and driven members in engagement without rotation with said ball still cammed into said groove.

24. The valve actuator of claim 23 wherein:
said motor driven selectively allows said driving and driven members to separate whereupon said bias on said shaft rotates said driven member to move said cam off of said flat spot and up said camming surface, and as a result said ball backs out of said groove and said bias on said shaft shifts it longitudinally.

25. The valve actuator of claim 24 wherein:
said housing is configured to interchangeably accept electric and hydraulic drivers to engage said drive for movement of said shaft.

26. The valve actuator of claim 25 wherein:
said housing accommodates a plurality of drivers, at least one powered electrically and at least one powered hydraulically.

27. A valve actuator comprising:

a housing;

at least one motor driver mounted to said housing;

a drive connected to said driver;

a shaft operably connected to said drive by a clutch, said shaft biased toward a first direction and said shaft connectable to the valve;

said motor driver through said drive overcoming said bias on said shaft to move said shaft in a second direction;

said clutch selectively operable to disengage said drive from said shaft to allow said bias to translate said shaft in said first direction;

said housing configured to interchangeably accept electric and hydraulic drivers to engage said drive for movement of said shaft.

28. The valve actuator of claim 27 wherein:

said housing accommodates a plurality of drivers, at least one powered electrically and at least one powered hydraulically.

29. The valve actuator substantially as hereinbefore described with reference to the accompanying drawings.

The Patent Office

25

Application No: GB 9706926.4
Claims searched: 1-17

Examiner: Tim James
Date of search: 25 June 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F2V (VS1, VS40)

Int Cl (Ed.6): F16K (31/00, 31/04)

Other: On-line: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	WO 96/04494 A1	(Rotork) see page 4 line 25 - page 7 line 1, page 8 line 9 - page 9 line 10 and page 11 line 26 - page 12 line 3	1-3
X	WO 80/00483 A1	(Johnston) see page 9 lines 8-15 and page 10 lines 3-18	1 and 17
X	US 3921264	(Madonian et al) see column 2 lines 36-62 and column 5 lines 36-62	1 and 2

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

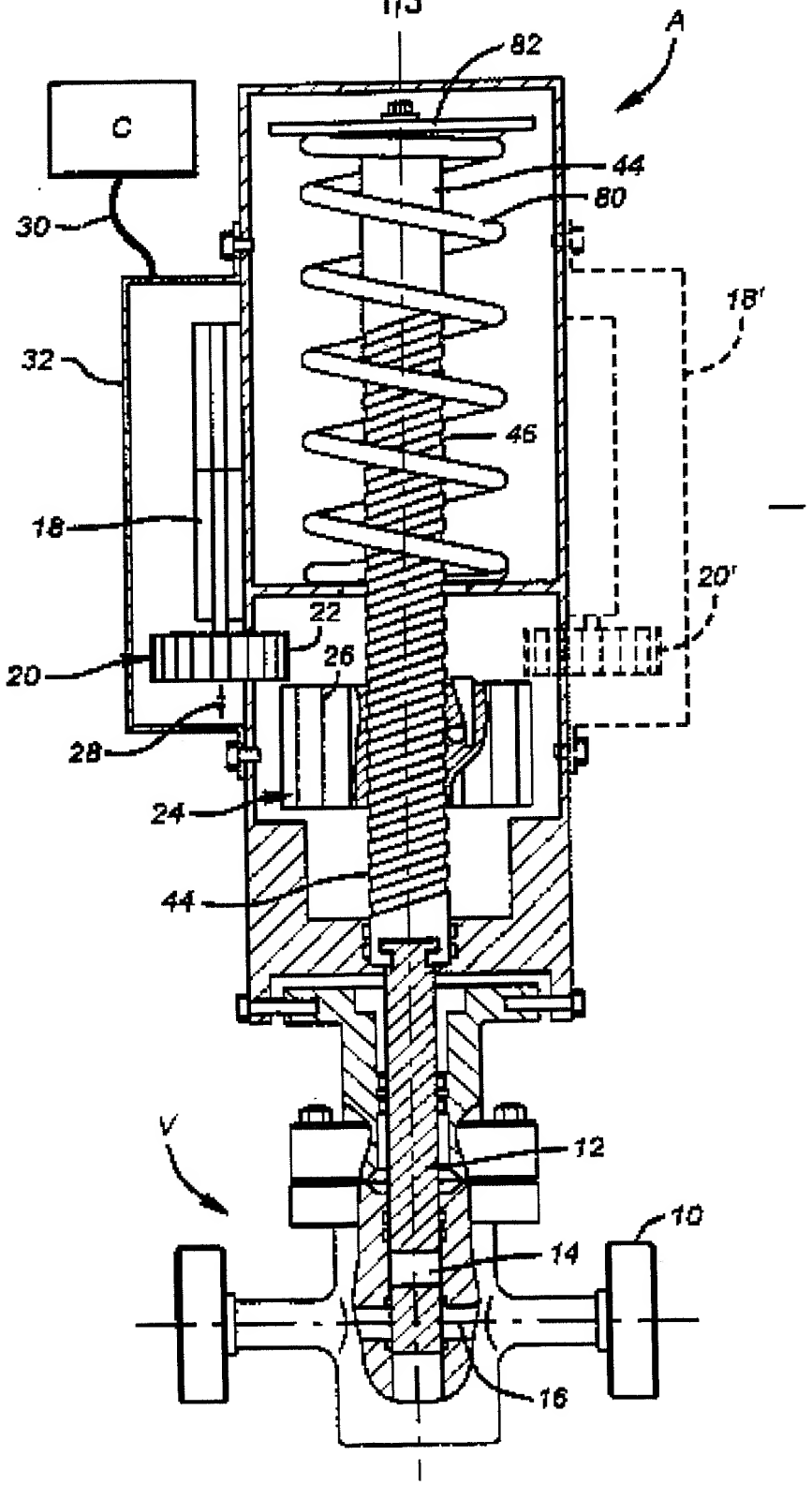

FIG. 1

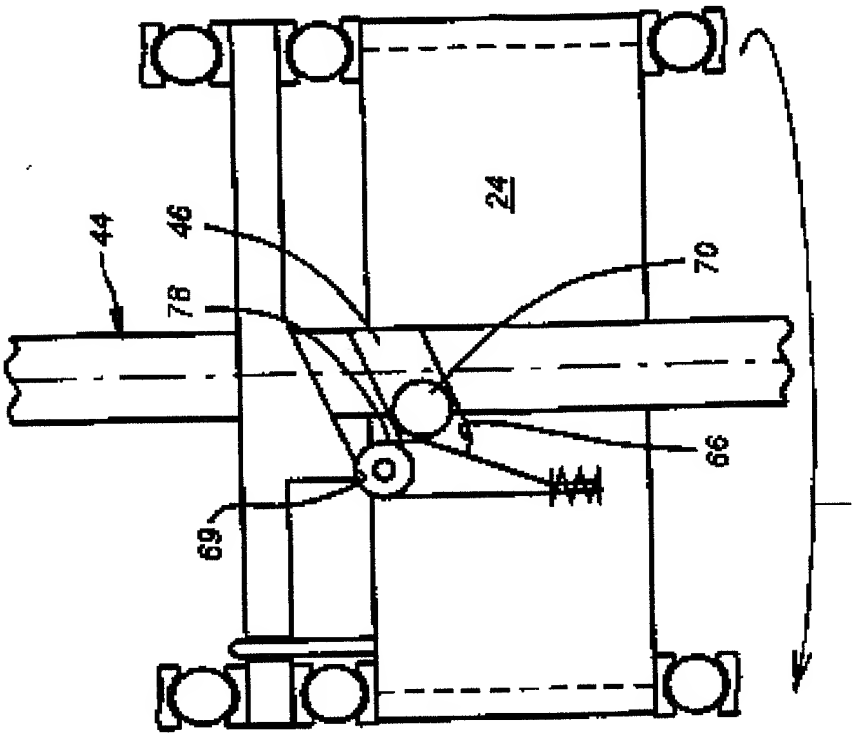

FIG. 3

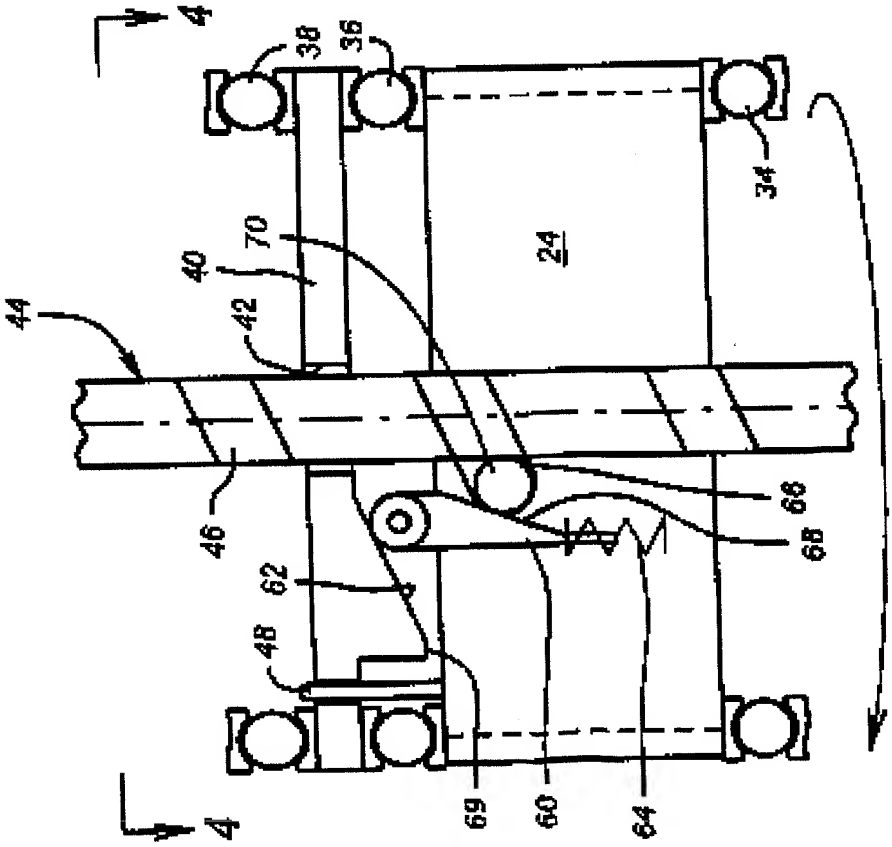

FIG. 2

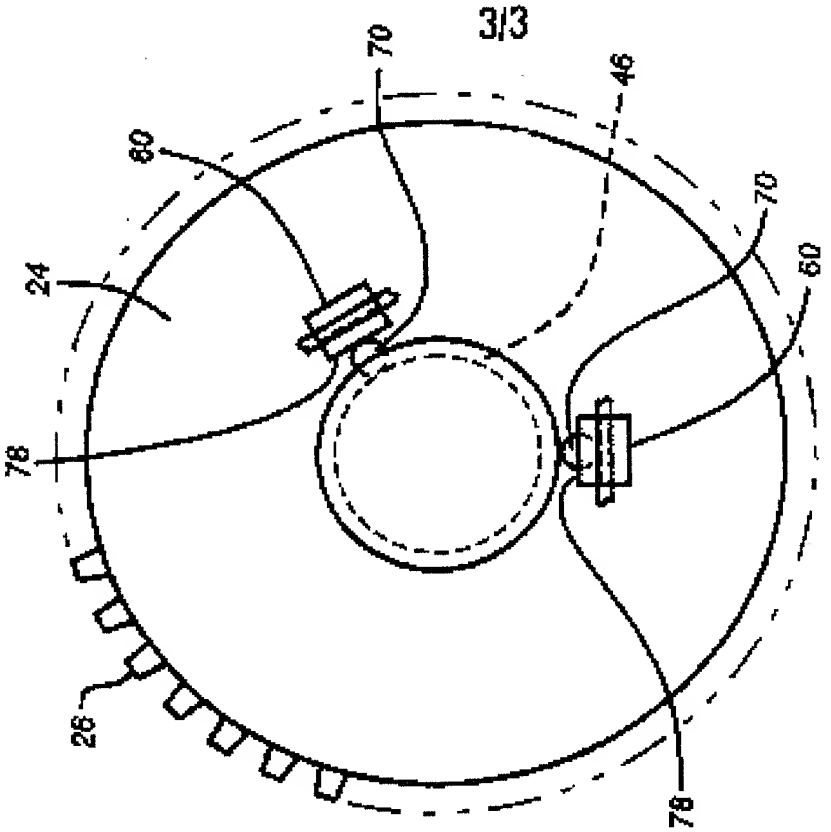

FIG. 5

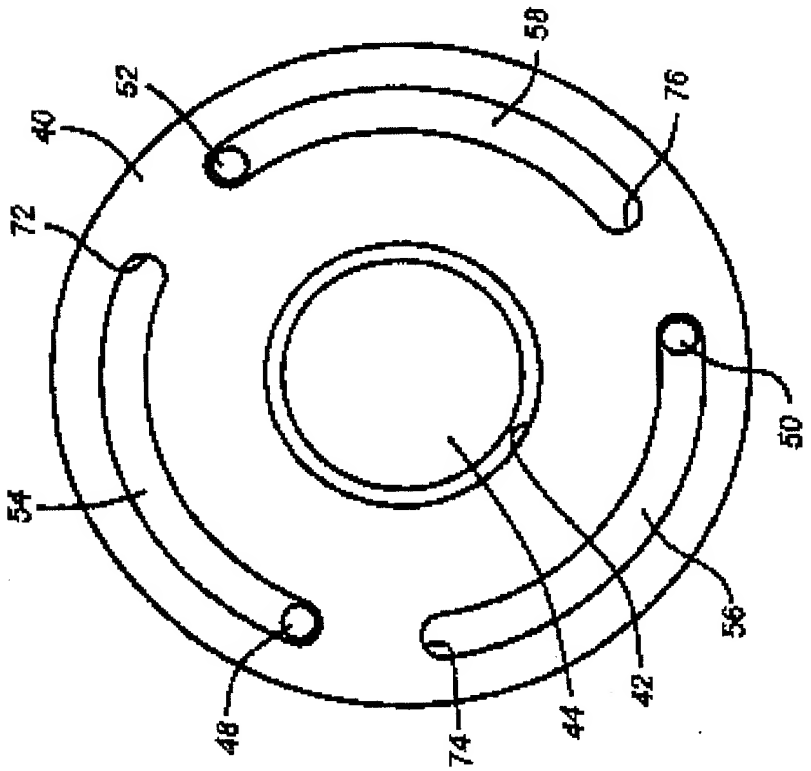

FIG. 4